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ABSTRACT

The objective of this study was to investigate how classroom questioning and discussion skills, designed to increase scientific literacy and problem solving performance, affects student achievement in biology and chemistry. The two independent variables for this study were the effects of wait time and supportive intervention. The dependent variables used were the grades of students on the Biology and Chemistry Regents Examinations in the State of New York. Forty-four teachers from 15 suburban and rural high schools located in four central New York counties provided the data set. Each teacher designated one class as an experimental unit and provided them with instruction using the techniques of wait time and supportive intervention. Results varied between the chemistry and biology groups. Indications were that since biology instruction uses memorization, the effects of the independent variables were not significant. In chemistry, there was no difference in the grades of students in the classes of teachers who received supportive intervention. In biology, however, the students performed at significantly lower levels. Also in biology, the presence of "wait timers" made little difference in achievement, except with students in the highest ability group. Five tables and six figures are included. (TW)

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INTERACTION OF ABILITY WITH WAIT TIME AND SUPPORTIVE INTERVENTION IN BIOLOGY AND CHEMISTRY ACHIEVEMENT

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Interaction of ability with wait time and supportive intervention in biology and chemistry achievement

Purpose

National commissions on the study of educational excellence such as the National Science Board, the National Commission on Excellence in Education and the Carnegie Task Force on Teaching have called for extensive modifications of approaches to science teaching in the schools. The National Science Board (1983) sees a "new basics" as essential. It should include "communication and higher problem solving skills, and scientific and technological literacy -- the thinking tools that allow us to understand the technological world around us" (p. v). The objective of this project was to enhance classroom questioning and discussion skills in order to increase scientific literacy and problem solving performance, leading to improved achievement. The major focus was to improve instructional procedures and practices through wait time and supportive intervention.

Theoretical Basis

Several studies have reported a significant relationship of achievement to wait time. Treatment durations have varied from a single lesson (Riley, 1986) to 13 weeks (Tobin, 1980). The ability level of the students was not a variable in these studies.

A research synthesis by Yeany and Padilla (1986) indicated that peer or supervisor feedback was essential in improving science teaching behaviors. One method that provided for feedback in a non-threatening atmosphere was that of supportive intervention (Swift, Swift, & Gooding, 1985). This was defined

as a process by which feedback was provided in a facilitative manner following an analysis of teaching by trained observers. It was considered as a refinement of peer coaching (Joyce & Clift, 1984).

Most schools in New York State follow the same curriculum and use the same final examination in secondary level subjects, permitting the comparison of achievement in different schools. This study used the New York State Regents Examinations in chemistry and biology as criterion instruments during an academic year-long study. The uniform curricula, common final examinations, and similar intellectual and socio-economic status of the student population provided advantages not often found in multiple school studies.

Procedure

The two independent variables, the effects of wait time and supportive intervention, necessitated a 2 by 2 factorial design. The dependent variables reported are the grades of students on the Biology and Chemistry Regents Examinations. Grades in the science course taken last year, which served as the measure of ability level, were self-reported on a survey as 90 - 100% (high); 80 - 89% (medium); 79% or less (low). This item was omitted if no science course was taken in the previous year.

The source of the data set was 44 teachers from 15 suburban and rural high schools located in four central New York counties. Equal numbers of teachers of the biology and chemistry curricula designed for college-bound students were selected. At least two, but not more than four, teachers were selected from each

participating high school. The teachers had a mean of 17 years of teaching experience. Each teacher designated one class as the experimental unit. There were 505 biology and 442 chemistry students in the sample. Of these,375 biology students and 270 chemistry students completed a science course during the preceding year, enabling them to be classified by ability level. Sample data, state-wide means and reliability coefficients (State Education Department, 1987) are included in Table 1. The sample was divided into 4 groups, according to the treatment conditions.

Results

The Regents Examination scores in Biology and Chemistry were evaluated by two separate univariate analyses of variance with three variables: wait time, supportive intervention, and ability level. Results are shown in Tables 2 and 3. For biology there was a main effect for supportive intervention F (1,363)=5.56, $p<.02$. Students from classes of teachers receiving supportive intervention scored lower than students from classes of teachers not receiving supportive intervention. There was no main effect for wait time. However, there was an interaction of wait time and supportive intervention $F(1,363)=3.88$, $p<.03$ (see Table 4). The group using a wait time feedback device, a "Wait Timer", and not receiving any supportive intervention attained the highest mean. When ability level was evaluated, a significant effect of wait time by ability level interaction was obtained, $F(2,363)=3.88$, $p<.05$. Wait time had no effect at the lowest ability level and a large effect on the highest level. These results are shown graphically in Figures 1, 2, and 5.

For chemistry students there was a main effect for wait time with the wait time group being associated with higher scores $F(1,258)=6.26$, $p<.02$ (see Tables 1 and 2). Although there was not a significant interaction of wait time by ability level $F(2,258)=2.36$, $p=.09$, as shown in Table 4, the Wait Timer was associated with enhanced Regents scores for lower level students and for higher ability students, but had little effect on middle level students. There was no effect of supportive intervention nor was there an interaction of supportive intervention by wait time. The results are shown graphically in Figures 3, 4, and 6.

Discussion

Distinctly different results were obtained for the biology and chemistry groups. While a definite answer concerning this dissimilar result must await further research, we offer the following speculative thoughts:

1. Our analysis of 22 biology classes and 22 chemistry classes for the academic year 1985-86 leads us to hypothesize that biology at the high school level is focused more at the memorization level than chemistry. Chemistry involves more problem solving and assessment. Students and teachers spend more time in biology drilling on names and terminology. Such memorization and drill lessons receive less benefit from thought provoking pauses provided by wait time. Indeed, we have found that in drill situations wait times of 3 seconds can be frustrating to both teachers and students alike. Therefore, we believe that it may be this difference in the delivery approach to the content that contributed to the differential results in

biology and chemistry.

2. In chemistry there was no difference in the grades of students in the classes of teachers who received supportive intervention. However, in biology, the students performed at a significantly lower level. The focus on discussions in science may have served as an obstruction to the memorization of facts and definitions, with lower achievement resulting.

3. In biology, the presence of Wait Timers made little difference in achievement, except with students in the highest ability group where there was a 4.83 point improvement. In chemistry, differences were apparent in all ability groups. Differences favored the lowest ability group, 6.86 points, but were also large with the highest group, 4.41 points. These differences are substantial, in view of the small effective range of the test (99% of the students' grades were in the 65-100% range) and the low ceiling on the test (100% with a mean of 89% for the high scoring groups).

Implications

The pilot study for this project (Swift, Swift & Gooding, 1985) indicated that supportive intervention enhanced the behaviors that increased wait times improved spontaneously. In the pilot study, the teachers had used Wait Timers during the prior year. It may be that these two techniques need to be applied serially, so the teachers can become accustomed to the use of Wait Timers prior to further growth with intervention techniques.

It appears that wait time yields positive results for the majority of students. The large increment for the brightest students is interesting and permits speculation.

It may be that the biology curriculum should be modified to include more problem solving opportunities. On the other hand, if the curriculum is to continue to stress factual information and memorization, the teaching methods for biology will need to be changed to emphasize that objective.

ACKNOWLEDGMENT

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References

Joyce, B. & Clift, R. T. (1984). Teacher education and the social contest of the workplace. Childhood Education, 61, (2), 115-121.

National Science Board Commission on Precollege Education in Mathematics, Science and Technology. (1983). Educating Americans for the 21st century (CPCE-NSF-03). Washington, DC: National Science Foundation.

Riley, J. P. (1986). The effects of teachers' wait-time and knowledge comprehension questioning on science achievement. Journal of Research in Science Teaching, 23, 335-342.

State Education Department. (1987). Percentile equivalents and reliability data for the June 1986 Regents examination. Albany, NY: Bureau of Elementary and Secondary Testing Programs.

Swift, J. N., Swift, P. R., & Gooding, C. T. (1985, April). Two effective ways to implement wait time. Paper presented at the meeting of the National Association for Research in Science Teaching, French Lick Springs, IN.

Tobin, K. G., (1980). The effect of an extended wait time on science achievement. Journal of Research in Science Teaching, 17, 469-475.

Yeany, R. H., & Padilla, M. J. (1986). Training science teachers to utilize better teaching strategies: A research synthesis, Journal of Research in Science Teaching, 23, 85-95.

Table 1

Sample Data

	Ability Group				
	Low	Medium	High	Total	State
Biology					
Mean	71.45	78.33	85.74	78.75	75.2
N	103	155	117	375	
Chemistry					
Mean	69.30	78.21	88.45	80.66	76.2
N	43	125	102	270	

Reliability (K-R 21)

Biology	.90
Chemistry	.89

Table 2

Final Examination Means in Biology and Chemistry by Treatment and Ability Level

Biology

Group	Ability Level: Low	Medium	High	Total
Wait Time				
Without	71.25	79.23	83.24	77.90
(N)	(61)	(88)	(54)	(203)
With	71.74	77.15	87.87	79.76
(N)	(42)	(67)	(63)	(172)
Supportive Intervention				
Without	73.29	79.63	86.38	81.39
(N)	(28)	(87)	(76)	(191)
With	70.76	76.66	84.54	76.01
(N)	(75)	(68)	(41)	(184)

Chemistry

Group	Ability Level: Low	Medium	High	Total
Wait Time				
Without	65.95	77.98	85.68	78.21
(N)	(22)	(63)	(38)	(123)
With	72.81	78.44	90.09	82.71
(N)	(21)	(62)	(64)	(147)
Supportive Intervention				
Without	68.95	77.90	88.41	80.28
(N)	(22)	(63)	(49)	(134)
With	69.67	78.52	88.48	81.04
(N)	(21)	(62)	(53)	(136)

Table 3

Analysis of Variance

Regents examination score in biology or chemistry

by

SI Supportive intervention
WT Wait Timer
ABILITY Achievement in previous science course

	Biology			Chemistry		
Source of Variation	df	F	Sig.	df	F	Sig.
Main Effects	4	30.021	.000	4	36.814	.000
SI	1	5.575	.019	1	.024	.876
WT	1	.626	.429	1	6.259	.013
ABILITY	2	44.595	.000	2	65.943	.000
2-Way Interactions	5	2.251	.049	5	.981	.430
SI WT	1	4.470	.035	1	.007	.932
SI ABILITY	2	.155	.857	2	.153	.858
WT ABILITY	2	3.884	.021	2	2.355	.097
3-Way Interactions	2	.190	.827	2	.721	.487
SI WT ABILITY	2	.190	.827	2	.721	.487
Explained	11	11.974	.000	11	13.964	.000
Residual	363			258		
Total	374			269		

Table 4

Interaction Effects

Biology

	Supportive Feedback: Absent	Supportive Feedback: Present	
Wait Time Feedback: Absent	80.86	74.79	77.90
Wait Time Feedback: Present	82.02	77.44	79.76
	81.39	76.01	78.85

Chemistry

	Supportive Feedback: Absent	Supportive Feedback: Present	
Wait Time Feedback: Absent	78.46	77.91	78.21
Wait Time Feedback: Present	82.09	83.23	82.71
	80.28	81.04	80.66

Figure 1.
Mean Final Examination Scores: Biology

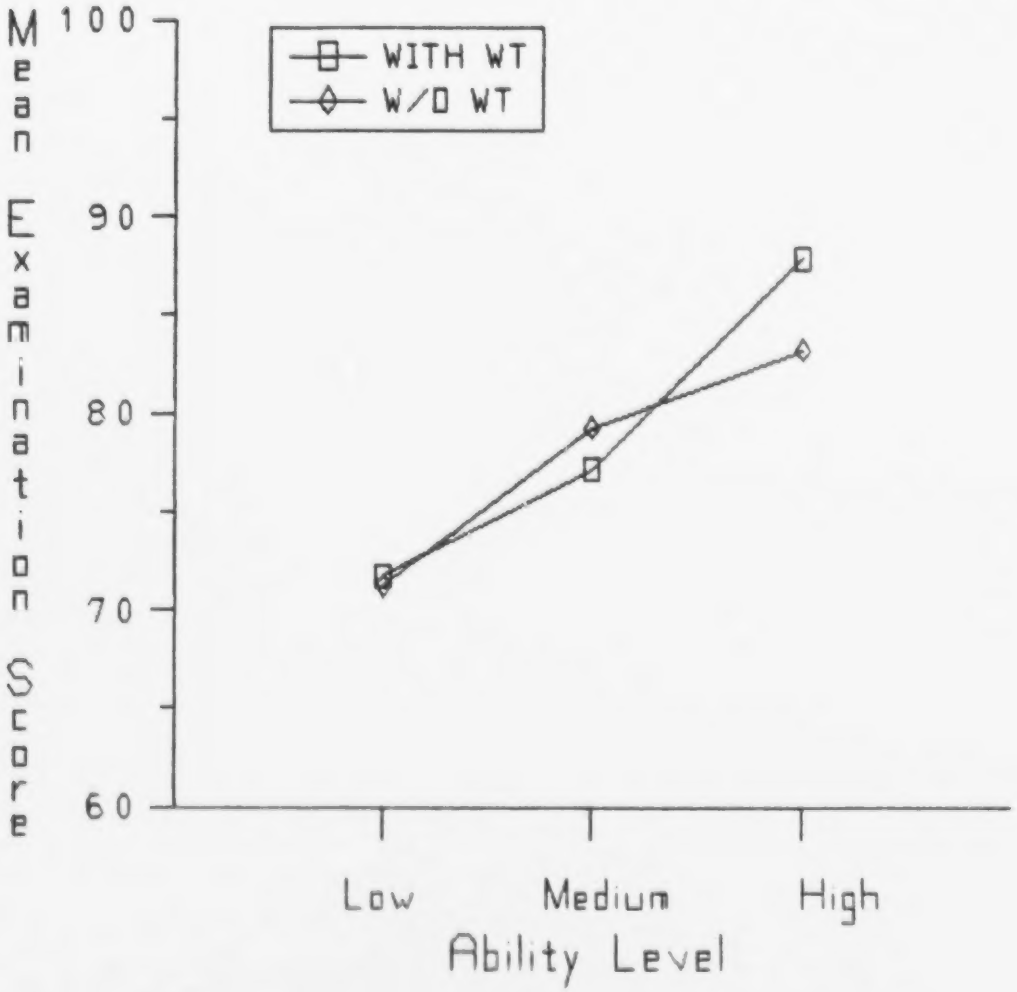

Figure 2.
Mean Final Examination Scores: Biology

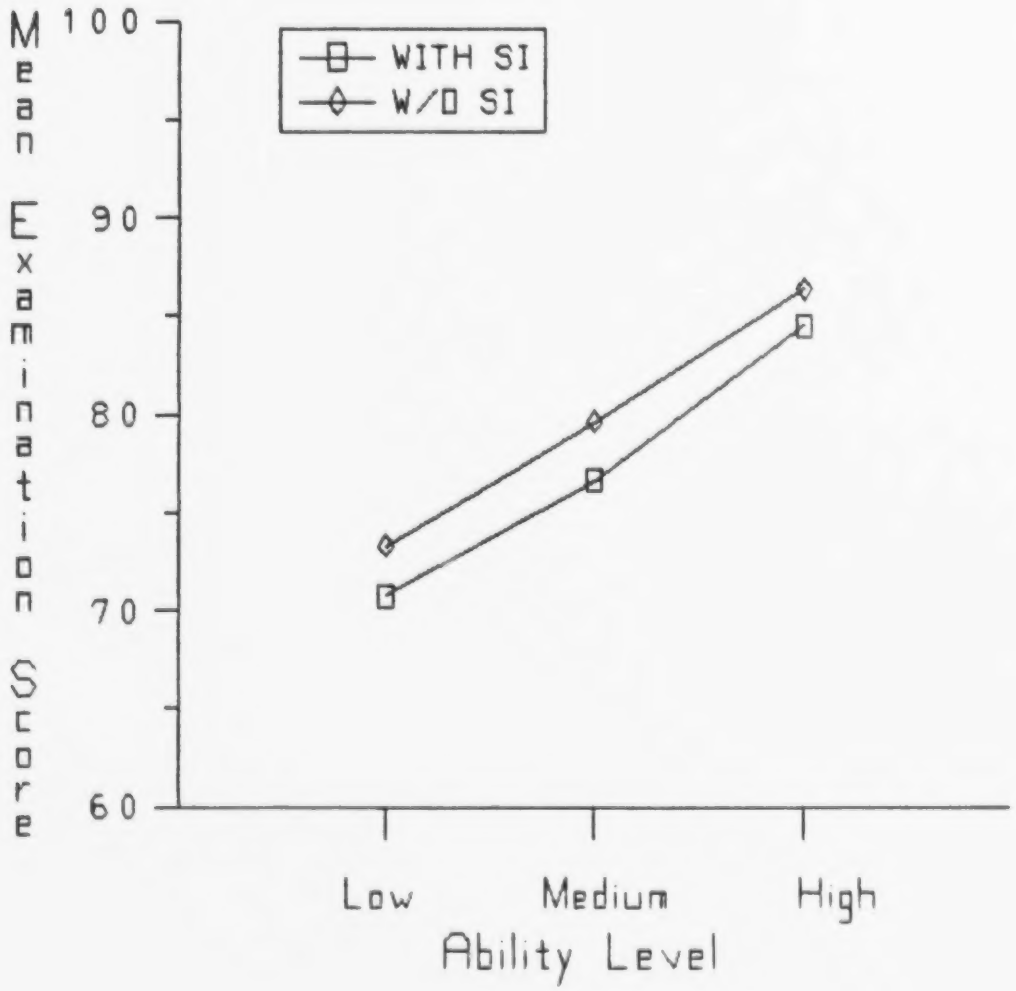

Figure 3.
Mean Final Examination Scores: Chemistry

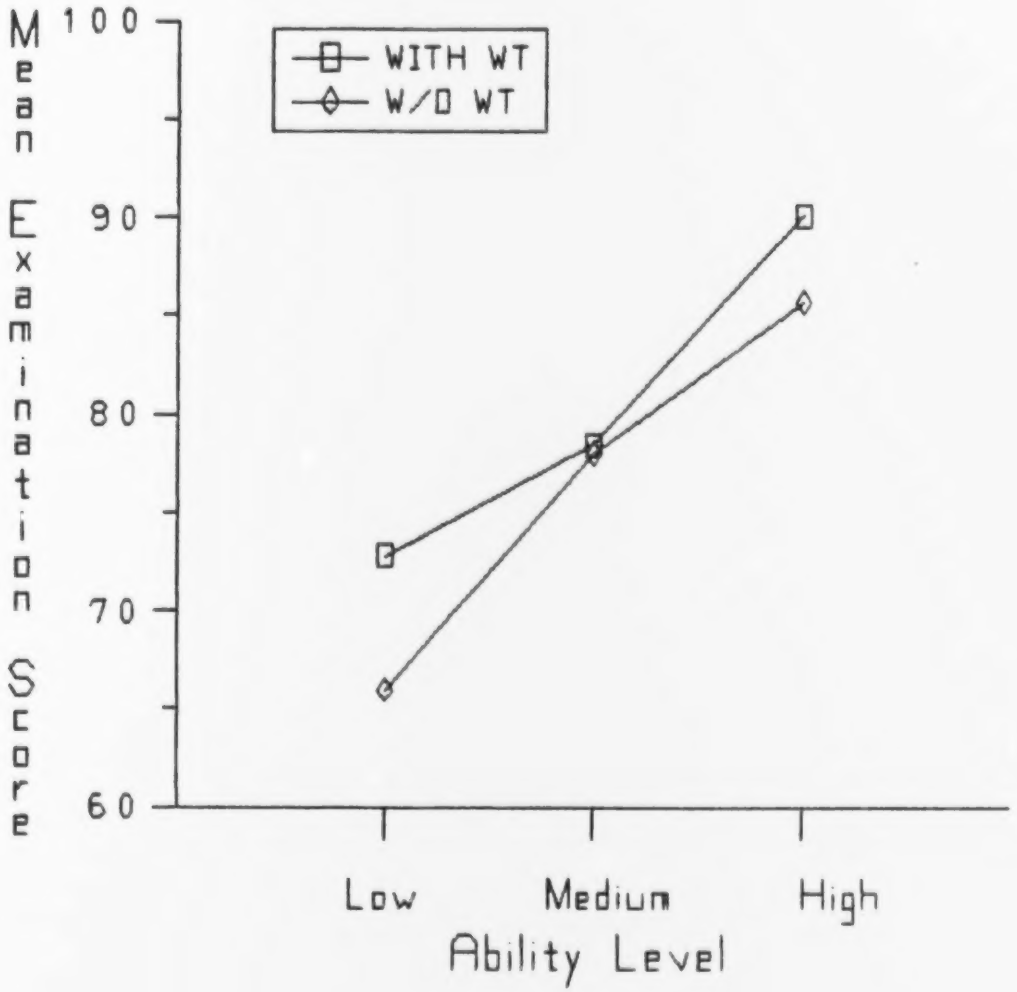

Figure 4.
Mean Final Examination Scores: Chemistry

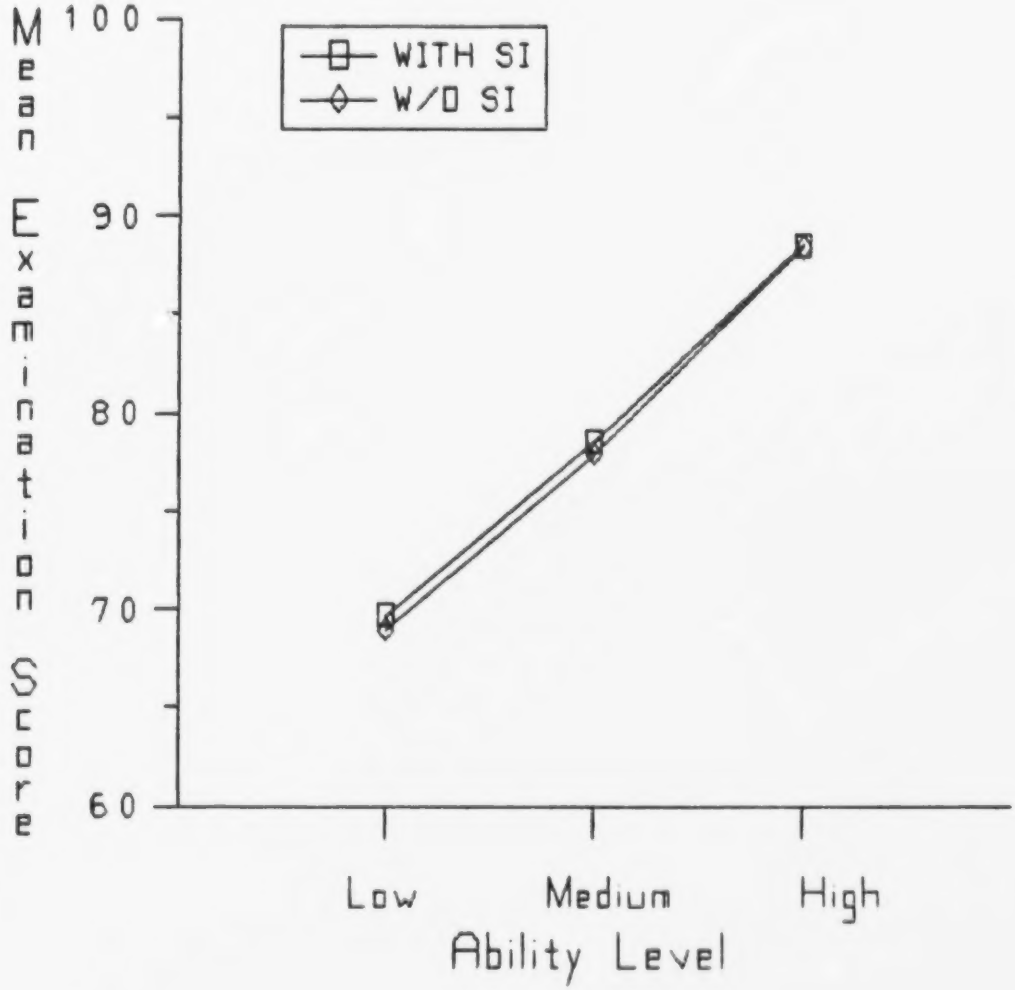

Figure 5.
Mean Final Examination Scores: Biology

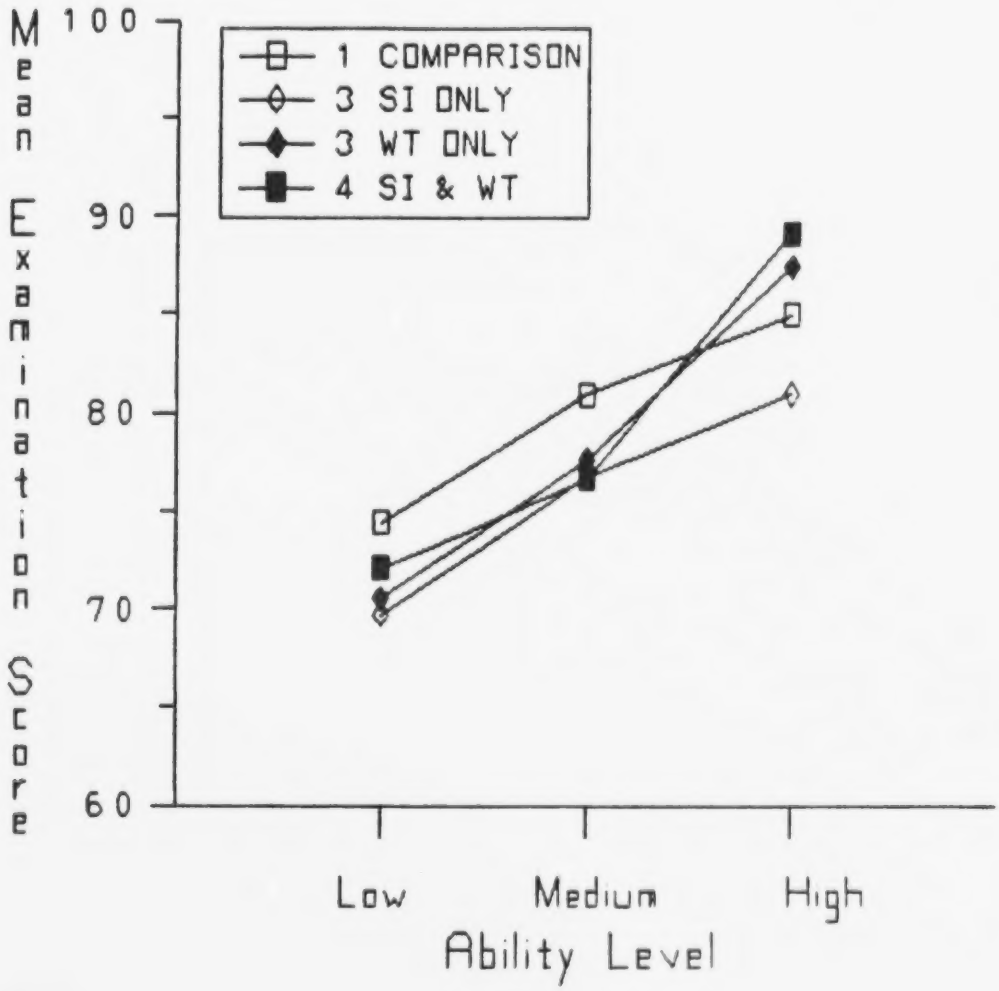

Figure 6.
Mean Final Examination Scores: Chemistry